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Dr. Hayden visited the locality of Mr. Lucas' excavations, and informs me that the formation from which the *Camarasaurus* was obtained, is the Dakota. Prof. Marsh has attempted to identify what is, according to Prof. Mudge, the same horizon, one hundred miles north of Canyon City, with the Wealden of England. Specimens from the northern locality which I have examined render it certain that the horizon is that of Mr. Lucas' excavations. Of this I may say that there is no palæontological evidence of its identity with the Wealden. The resemblance of the vertebrate fossils to those of the English Oolite is much greater, but not sufficient as yet for identification.

The discovery of *Vertebrata* in the strata of the Dakota epoch is an important addition to the geology and palæontology of North America. Credit is due to Superintendent O. W. Lucas for this discovery, and also in an especial manner for the skill and care he has exercised in taking out and shipping the ponderous specimens.

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THE DISCOLORED WATERS OF THE GULF OF CALIFORNIA.

BY THOS. H. STREETS, M.D., U. S. N.

ONE of the earliest names given by the old Spanish navigators to the body of water that lies between the peninsula of Lower California and the western coast of Northern Mexico was the Vermilion sea. It was also known in the earlier times as the Mar de Cortez, and Mar Laurentano; or the Mar Vermiglion, Mar Rojo, and Mar Vermijo, on account of the reddish color of its waters; and more recently as the Mar, or Gulfo, de California.

The names Vermiglion, Vermijo, and Rojo seem to have been applied as early as between the years 1537 and 1540, after the explorations of Ulloa and Alarcon, and from the accounts given of it by Nuño de Guzman and his officers, who were the conquerors and rulers of Sinaloa, a state bordering on the gulf.

In all these narratives, however, it is well to note that two entirely distinct causes of discoloration are confounded. Father Consag and Ugarte, in particular, speak of the brick-colored corrosive water of the gulf-head, which is altogether different from the more vermilion-colored patches at the mouth of the gulf, which were, doubtless, what suggested the name Vermilion sea.

J. Ross Browne, at a recent date, and before him De Mofras, discredited the statements of the old Spanish sailors, and attributed the red color to the reflection in the water of the brilliant, rosy-tinted clouds of sunset.

We had ample opportunity to verify the truth of the Spanish account during the extended survey of the gulf and its shores by the U. S. Steamer "*Narragansett*," in 1875.

We first saw patches of the red water south of Ciralbo island. The steamer was stopped and a bucket was thrown overboard to secure some of it for examination. The water thus procured revealed nothing when subjected to the test of the microscope; it was perfectly transparent. The failure to discover the cause in this instance was due to the fact that the coloring matter does not float upon the top of the water, but is suspended several feet below; and when this was ascertained, by putting a lead in the bucket and sinking it a half fathom or more below the surface, there was no difficulty in obtaining all that was desired.

When first drawn up and viewed in a glass vessel by the unaided eye the water had a faint reddish tinge. When allowed to stand for a half hour the coloring matter settled to the bottom of the vessel as a greenish-yellow precipitate; and when some of this was taken up by a pipette and examined under the microscope, it was seen to be composed of minute roundish bodies. Further on these were proven to be the remains of ciliate infusoria.

The latter fact was not discovered, however, until after much painstaking investigation. Some small objects had been seen repeatedly to dart across the field of vision when the water was placed fresh upon the glass slide, but they disappeared as they came, like a flash, and it was a long time before their disappearance could be satisfactorily accounted for. The molecules were the only bodies that were permanent, and I was inclined to attribute to them the phenomenon of the water. Finally, one of the little bodies mentioned above stopped directly in the centre of the field of vision, and commenced a rapid rotatory movement, which presently ceased, and the animal was quiescent for a second or two; when lo! a rupture occurred, its molecular contents oozed out, and its transparent envelope became invisible. This then was the solution of the mystery. Afterwards, knowing what to search for, there was no difficulty in seeing the same process repeated again and again.

Mr. Darwin in his "Naturalist's Voyage Around the World," encountered a patch of similarly discolored water off the coast of Peru. According to his account, the water when examined by the microscope was "seen to swarm with minute animalculæ darting about and often exploding. Their shape is oval and contracted in the middle by a ring of vibrating curved cilia. It was, however, very difficult to examine them with care, for almost the instant motion ceased, even while crossing the field of vision, their bodies burst." From the foregoing it is evident that the water of the two localities is discolored alike by the same cause.

Those from the Gulf of California exhibited the same rapid to and fro motion as the ones seen by Darwin, and this motion was succeeded by a rotatory movement on the longer axis. Sometimes the rupture took place as soon as the latter motion ceased, and at other times the animal was motionless for a few moments preceding its final dissolution; and it was during these intervals of quiescence, only now and then observed, that anything like a correct impression of its general outline and structure could be gained. The following is the result of numerous observations extending over considerable time. The animal is oval in outline, with a projecting lip at its broad extremity, fringed with cilia. The rotatory movement took place around the smaller end as a pivot, and it advanced the same end in its to and fro movements. The envelope is a transparent and, apparently, structureless membrane, and in its interior are greenish-yellow granules, or bodies with dark rims and bright centres. These bodies floated loosely in the cavity of the animal, for when it revolved they changed their places like pebbles in a revolving cask. They averaged about the 1–12000 of an inch in diameter.

According to Mr. Darwin the bursting, which generally occurred at the extremities of the body, is due to an expansion of the tegumentary covering. I can not reconcile this with the results of my own observations. On the contrary, I noticed a contraction to take place in the transverse axis of the body; its length was increased and its transverse diameter diminished; in other words, the oval form was replaced by an oblong. This will better illustrate why the rupture generally took place at one of the extremities of the body. If these observations are correct the bursting of the envelope would be the result of an active rather than a passive action. The only reasonable way of accounting for an expansion of the body-covering would be by an imbibition of water from the outside, and a rupture would as likely occur in one place as in another in such a case.

When confined in a drop of water, or in an animalcula cage, the little animals never lived as long as a minute, the field of vision was often strewn with their remains before the observer had time to look through the tube of the microscope. This was especially the case if some time had elapsed since their removal from the sea. When kept in a bucket or in any vessel containing a large quantity of water they lived for a much longer time.

Many experiments were made with destructive agents with the view of killing the animalculæ before they had time to destroy themselves, but the results were unsatisfactory. In every instance they failed to accomplish the end for which they were used; if they served any purpose it was to accelerate the process of self-destruction.

The only explanation that I can give for this suicidal propensity lies in the abstraction of oxygen from the water; yet this appears somewhat exceptional in view of the fact that this gas is rather immaterial to the existence of the low, structureless forms of animal life. The bacteria, for instance, will flourish in infusions that have been boiled and hermetically sealed.

We have a record of these minute animals having been in this locality for more than three hundred years, defying the combined action of the winds, waves, and currents, and remaining as closely aggregated as a community of individuals endowed with reason or instinct, and not exposed to dispersing causes. They apparently have great control over their movements, at least so far as regards the fixity of their positions.

The great Colorado River, at the head of the gulf, constantly pours into it an immense volume of water which has a tendency to carry things seaward, as it does logs and other drift; yet here is this microscopic animal, the 1-1000 of an inch long, exposed to the same influence, but remaining in its chosen locality for centuries. What keeps these masses together forever in one place in spite of the circulation of the waters on the surface of the earth? Well might the question have presented itself to the mind of Darwin, but his fertile imagination suggested no adequate solution for it.

Other patches of discolored water obey the same impulse. In

1835 Mr. Darwin investigated that off the coast of Peru. The earliest notice we have of its existence in that locality is the beginning of the nineteenth century, and a good authority might be cited for its existence there as late as 1872. In the latter year while sailing down the eastern coast of South America we passed through a tract, while off the mouth of the Rio de la Plata, where the surface of the water was covered with a thick scum, resembling saw-dust. Darwin, in 1832, or forty years previous, found it further north, in the vicinity of the Abrolhos Islets. In this case the material that discolors the water belongs to the vegetable kingdom. It is a "minute cylindrical conferva," the *Trichodesmium erythræum.* According to Ehrenberg, the color of the water of the Red Sea is due to the presence of a "peculiar genus of alga," and Darwin states, on another authority, that it is the same species as that found off the coast of Brazil. In the latter locality it would certainly argue a defect of the vision to call the water red. Old sailors call it whales' feed, which, with them, is the generic title of everything that discolors the water of the ocean.

"The brick-colored and corrosive waters of certain parts of the gulf-head" received an easier solution at our hands than the more vermilion patches of the mouth of the gulf. The former is spoken of as being so extremely caustic as to remove the skin from the body like a blister, and to cause obstinate boils and ulcers, similar to those produced by scurvy, and which lasted for a long time. Some have gone so far as to even state that it would rot the clothes of those who were incautious in meddling with it. A recent compiler has endeavored to account for this peculiar property of the water on the supposition of an "excess of the iodides, bromides and sulphurets of minerals, derived, doubtless, from the abundance of volcanic material so common in these portions of the gulf." But as is common in such cases of explanatory guessing, his answer is not the true one.

Most of our information concerning this water has come down to us with the accounts of the voyages of Father Consag and Ugarte, both of whom confined their explorations, in these parts, to the head waters of the gulf; the former in 1746, and the latter in 1721.

We encountered this peculiar caustic water in about the same locality assigned it by Consag and others. In the Bay of Muleje, an indentation in the coast more than half way up the peninsula, the whole surface of the water was of a milky-red color. The body that gives to this water the strangely caustic properties is not a mineral, but an animal—a flagellate infusorium—the common *Noctiluca miliaris.* In this well-sheltered bay they accumulate from their light specific gravity at the top of the water. How thick the stratum was we did not ascertain, but we may form some idea of its extent from the fact that we steamed through the tract in a straight line for four or five hours at a speed of about five knots per hour. We dipped a canvas bucket in their midst, and when the water drained off it remained half filled with the animalculæ. They resemble minute grains of boiled sago. Every drop of water was literally crowded with them. They were so small that it required two or three to cover the area of a pin's head. It is very easy to comprehend how, if this bay were agitated by the slightest cause, it would glow as a broad sheet of living fire.

The Spanish sailors bathed in this water, and according to their chroniclers their bodies were covered with boils and ulcers in consequence. They were only half-way right when they attributed their infirmities to the water. The lashes of the little *noctiluca* were, undoubtedly, the exciting agents—the direct cause of their troubles; but that they were insufficient, in themselves, to account for the severity of the symptoms the evidence of our own men under different conditions of bodily health sufficiently proves. That their ulcers were similar to the effects of scurvy they recognized; and that a scorbutic condition of the blood played an important part in their production is evident. All sailors in those days were more or less the subjects of scurvy, which was a greater obstacle to the spread of commerce than were the small crafts of the navigators. It is a disease that often manifests itself in the form of boils and ulcers, and it exaggerates all trivial bruises and injuries of the skin. If our own sailors had been scorbutic when they bathed in the water the same train of symptoms would undoubtedly have followed; and, as it was, the skin, in places, became considerably inflamed and swollen, but the only disagreeable symptoms were the burning and tingling that accompanied the inflammation, which was of short duration.